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THE UPPER CRETACEOUS PIERRE
SHALE OF SOUTH DAKOTA

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GALE A. BISHOP

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ABSTRACT—Four specimens of *Sodakus tatankayotankaensis* n. gen., n. sp., and 12 specimens of *Raninella oaheensis* n. sp. collected from the Moberly Member of the Pierre Shale (Maastrichtian) in South Dakota are described and compared with allied forms. The specimens form part of the *Dakoticanter* Assemblage.

INTRODUCTION

BISHOP (1972b) described repeated fossil decapod assemblages from the Pierre Shale of South Dakota (Text-fig. 1) which are restricted to thin intervals of shale (3–4.5 m in thickness) but are laterally persistent over wide areas (15–1,500 sq. km) (Text-fig. 2). The assemblages are dominated by the crab *Dakoticanter overanus* Rathbun, 1917, cephalopods of the genus *Baculites*, and inoceramid bivalves. Numerous other taxa are each represented by relatively few specimens. The dominant brachyuran, *Dakoticanter overanus*, is represented by about 5,000 specimens. The decapod taxa are: *Dakoticanter overanus* Rathbun, *Necrocarcinus pierrensis* (Rathbun), *Homolopsis punctata* Rathbun, *Raninella oaheensis* n. sp., *Sodakus tatankayotankaensis* n. sp., *Homolopsis* sp., *Hoploparia* sp., and *Callianassa* sp. The specimens are all preserved as apatite concretions which weather out of the shale and are found concentrated on barren bentonitic slopes.

Three of the four known specimens of *Sodakus* were found at the Sitting Bull site of the Moberly locality, Corson County, and one from old Armstrong County, South Dakota. Twelve specimens of *Raninella* were found along the shores of the Missouri River in Corson, Dewey, Stanley, and Lyman counties, South Dakota (Table 1). All the specimens are from the upper part of the Pierre Shale. *Sodakus* was found in the Zone of *Baculites grandis* Hall and Meek and is Maastrichtian in age. *Raninella* was found in the zones of *Baculites scotti* Cobban and *Baculites grandis* Hall and Meek and therefore ranges through

the upper Campanian into the Maastrichtian (Gill and Cobban, 1966).

SYSTEMATIC PALEONTOLOGY

Order DECAPODA Latreille, 1803

Suborder PLEOCYEMATA Burkenroad, 1963

Infraorder BRACHYURA Latreille, 1803

Section OXYSTOMATA H. Milne-Edwards,
1834

Superfamily DORIPOIDEA de Haan, 1841

Family DORIPPIDAE, de Haan, 1841

Genus *SODAKUS*, Bishop n. gen.

Type species.—The type species of genus *Sodakus* n. gen. is *Sodakus tatankayotankaensis* n. sp.

Etymology.—The generic name is an acronym of "South Dakota," *Sodakus*.

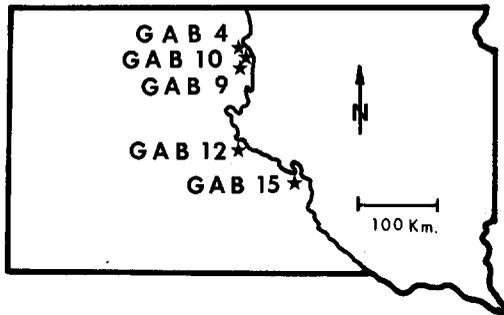
Generic diagnosis.—Crab longer than wide. Carapace rectangular in outline, slightly longer than wide, box-like, dorsum slightly convex, branchial regions inflated proximally and rise above the distal branchial and cardiac regions; lateral walls vertical, widest across the branchial regions; regions poorly separated by shallow furrows except for the deep cervical furrow; sternum narrow, first four sternal segments fused and with segments 5 and 6 form the plastron, the next two form the vertical hind wall; first two abdominal segments dorsal and narrow, not covered by carapace; last two pairs of walking legs dorsal.

SODAKUS TATANKAYOTANKAENSIS

Bishop n. sp.

Pl. 1, figs. 1–6; Text-figs. 3–4

Range.—Maastrichtian; Western Interior, North America.



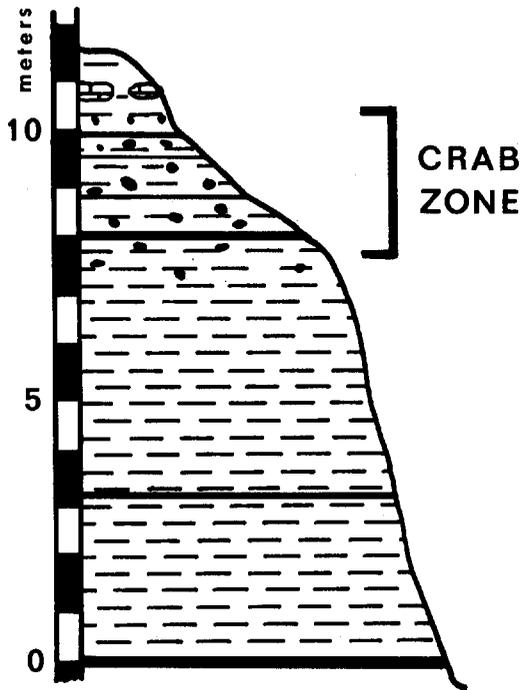
TEXT-FIG. 1—Location of collecting sites along Missouri River in South Dakota. Numbers correspond to Bishop localities (GAB-).

Etymology.—The trivial name is derived from the type locality, across the Missouri River from the town of Mobridge and below the grave of Tatanka Yotanka, The Sitting Bull, famed leader of the Hunkpapa Sioux Indians.

Type.—The holotype (GAB 4-1971) is deposited in the United States National Museum (USNM 173580). This specimen is an exfoliated steinkern that was collected at the Sitting Bull locality (Table 1) near the west abutment of the old bridge across the Missouri River (Oahe Reservoir) from Mobridge, South Dakota. It is from the Zone of *Baculites grandis* (Maastrichtian), Pierre Shale, Upper Cretaceous.

Sample size and preservation.—Four specimens are assignable to this species. All are body steinkerns, one is relatively complete, and all have been slightly eroded. The fourth specimen (not figured) was collected by W. A. Cobban of the U.S. Geological Survey in "Armstrong County" South Dakota at or near the type locality. This specimen is deposited in the U.S.G.S. (Denver) Collection.

Description.—The crab is rectangular, longer than wide (Table 2), with a box-like carapace (Text-fig. 3). The anterior margin straight with poorly differentiated orbits, rostrum unknown. Antero-lateral margins tightly rounded, vertical lateral margins slightly convex and widest across the mesobranchial regions at the anterior end of the cardiac region. Carapace is fairly level anterior and posterior to the cervical groove with an angle of about 165° between the slopes of the two areas. Postero-lateral margins are rounded. First two abdominal somites and last two pairs of pereopods are visible in dorsal view.



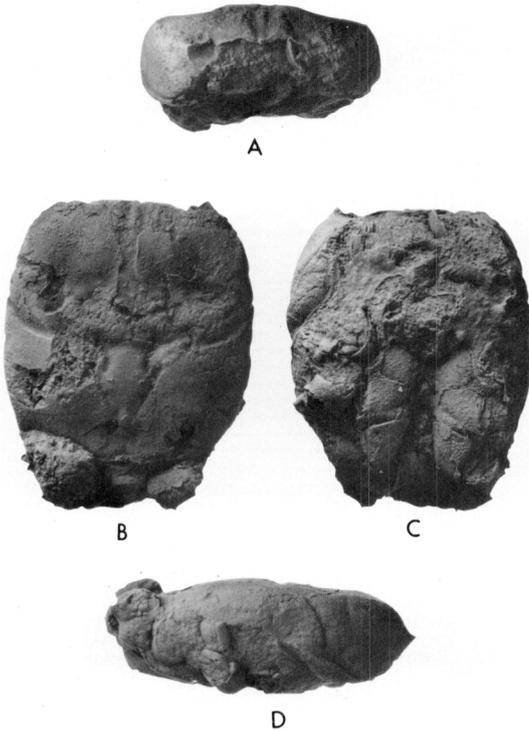
LEGEND

-  Shale
-  Bentonite
-  Concretions
-  limestone apatite

TEXT-FIG. 2—Measured section at Sitting Bull Site, Mobridge Locality, South Dakota.

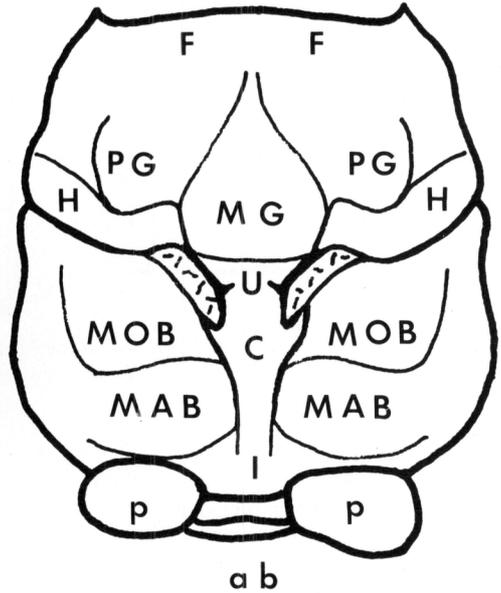
Cervical groove (Text-figs. 3B, 4) well defined, moderately deep, and relatively transverse. It forms a notch on the lateral wall which forms a smooth curve from the pleural suture upward and backward on the carapace edge then bends backward and inward on the dorsal surface on the carapace becoming nearly transverse except where it bends around the anterior edges of the epimeral muscle scars and then crosses the medial ridge as a shallow depression.

Cephalic arch relatively flat but a pair of broad shallow depressions separate the hepatic and protogastric regions. A shallow groove connects the depressions with the cervical fur-



TEXT-FIG. 3—*Sodakus tatankayotankaensis*, (GAB 4-2036). 3A, Anterior; 3B, Dorsal; 3C, Ventral and 3D, Right lateral view, approximately $\times 2$.

row near the anterior end of the epimeral muscle scars. The groove is deep as it proceeds forward and splits with one branch swinging forward and inward toward the rostrum and the other branch swinging outward and passing through the broad depression. This groove splits again as it passes through the depression; one branch proceeds outward to form a shallow groove on the lateral margin and the other branch turns forward toward the frontal region. The cephalic arch is thus divided into the medial gastric region, swollen protogastric regions anterior to and inside the broad depressions, and the hepatic regions behind and outside the depressions and lying between



TEXT-FIG. 4—Line drawing of carapace of *Sodakus tatankayotankaensis*. (F = Frontal, H = Hepatic, PG = Protogastric, MG = Mesogastric, C = Cardiac, U = Urogastric, I = Intestinal, MOB = Mesobranchial, MAB = Metabranial, ab = abdomen, and p = pereiopod.) Bar is 50 mm.

the cervical groove and the other anterior transverse groove.

The broad, flat branchial regions stand as a plateau above the poorly differentiated regions of the posterior part of the medial ridge. The medial ridge is bracketed anteriorly by large epimeral muscle scars, giving the medial ridge the appearance of an arrowhead pointed backward. The shaft of the "arrowhead" probably constitutes the urogastric region and the head of the "arrowhead" is the cardiac region. These areas are distinctly outlined laterally by the branchial-cardiac groove. Intestinal region is poorly differentiated. Branchial regions are highest along their proximal halves and slope gently to meet the vertical lateral wall. A poorly defined shallow depression on the dorsal

TABLE 1—Decapod collection sites.

Locality	Collection No.	Location
Sitting Bull	GAB 4—	SW¼, Sec. 18, T18N, R30E, Corson Co., S.C.
Promise	GAB 9—	SE¼, Sec. 29, T16N, R29E, Dewey Co., S.D.
BM J 304	GAB 10—	SE¼, Sec. 32, T17N, R30E, Dewey Co., S.D.
Peoria Bottom	GAB 12—	NE¼, Sec. 21, T6N, R29E, Stanley Co., S.D.
Counselor Creek	GAB 15—	SW¼?, Sec. 30, T107N, R72W, Lyman Co., S.D.

TABLE 2—Carapace measurements of *Sodakus tatankayotankaensis*.

Bishop	Specimen Number USNM	Length		
		Total*	Carapace	Width
GAB 4-1971	173580	20.1 mm	19.6 mm	18.2 mm
GAB 4-2030	—	18.6+	16.1+	16.2
GAB 4-2036	—	20.6	17.7	16.2

* Total length includes protruding abdomen.
+ = Length approximate and unmeasurable.

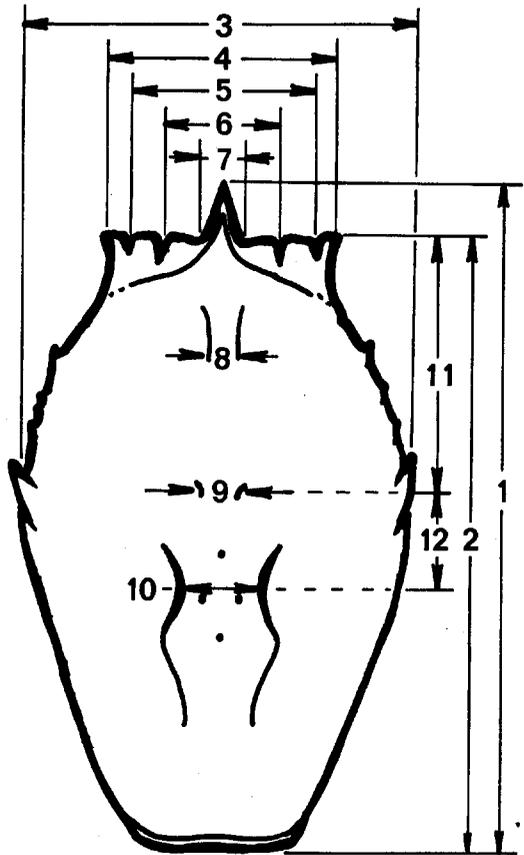
surface parallels the lateral margin forming a "ridge" along the outside of the branchial regions. The innerside of the branchial region on one specimen also has a poorly defined ridge bordered by an indistinct linear depression that swings onto the branchial region separating it into mesobranchial and metabranchial regions. The hind margin is slightly convex and slightly upraised into a narrow ridge.

The vertical lateral walls of the carapace are wedge-shaped in side view (Text-fig. 3D), being wider anteriorly. The smooth wall is interrupted by the cervical groove which meets the carapace edge perpendicularly, and the groove anterior to the hepatic region which slants slightly posteriorly at the top of the wall and more so near the lower margin.

The pterygostomial region is relatively narrow and appears to be almost parallel to the dorsal carapace surface (Text-fig. 3C). It is roughly triangular in shape and extends from one-third the distance from the anterior to the cervical groove backward to the midpoint of the carapace. The pterygostomial region is bordered by a granulate ridge on its outer edge.

The orbits are poorly defined, directed downward and forward, and nearly as wide as the carapace (Text-fig. 3A). A small forward facing spine is situated at the outer edge of the orbit.

The sternal plastron (Text-fig. 3C) is only half as wide and three-fourths as long as the carapace. The anterior part (sternal somites 1-2-3-4) is fused into a shield which comprises over half the total length of the plastron. The articulation of the chelipeds is formed by the posterior part of this shield. The rest of the ventral part of the plastron is formed by somite 5, which has a medial transverse groove, somite 6 which is smaller than 5 and wedge-



TEXT-FIG. 5—Line drawing of carapace of *Raninella oaheensis* with measured variables (see Table 3).

shaped, somite 7, which is very narrow, triangular, and mostly situated on the hind margin, and finally somite 8, which is larger than 7, is nearly longitudinal, and forms the rear of the ventral and the bulk of the hind margin of the crab. The abdominal groove is narrow and deep. The first two abdominal somites are dorsal. The last three segments are ventral. The last is short and triangular, the next to last long and rectangular, and the third from last only partly preserved. The other somites are not preserved. The proximal parts of the pereopods are preserved. The cheliped coxa (pereopod 1) has a large cross section and presumably indicates a large cheliped. Pereiopods 2 and 3 are ventral and their coxae are similar in size. The merus of pereopod 2 is flattened. Pereiopods 4 and 5 have large coxae and are situated on the dorsal side of the crab.

TABLE 3—Measurements (mm) of carapace of *Raninella oaheensis*. Those recorded in brackets are calculated from one measurement and the axis of symmetry. See Text-fig. 5 for measured parameters.

Bishop #	USNM #	Length including rostrum (1)	Length from orbits (2)	Carapace margins (3)	Base of orbits (4)	Distance Between						Orbits and gastric pits (11)	Gastric pits and center BCF (12)	
						Outer orbital fissures (5)	Inner orbital fissures (6)	Base of rostrum (7)	Anterior process of mesogastric lobe (8)	Gastric pits (9)	Branchiocardiac furrows (10)			
4-1795	—	—	—	(12.2)	—	—	—	—	—	—	1.2	25	—	2.2
4-1967	173589	20.8	19.4	(11.4)	(6.4)	(5.6)	(3.8)	(1.8)	—	—	—	2.0	—	—
4-1968	173584	—	—	(12.0)	—	(5.0)	(4.0)	—	—	—	0.9	1.9	6.3	2.4
4-1969	—	—	—	10.9	—	—	—	—	—	—	0.8	2.2	—	2.7
4-1970	173583	—	—	9.1	(5.0)	—	—	—	—	—	0.8	2.1	—	2.2
4-1983	—	—	—	—	(4.6)	(4.2)	(3.0)	—	—	—	—	—	—	—
4-2021	—	—	—	14.1	(5.4)	—	—	—	—	—	1.2	2.4	8.3	3.3
4-2037	—	—	—	13.3	7.4	—	—	—	—	—	1.1	2.6	8.3	3.3
9-19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10-136	—	—	—	(11.2)	7.2	—	—	—	—	1.0	1.2	2.5	—	2.8
12-3	173581	—	—	12.6	—	—	—	—	—	—	—	2.1	—	—
15-1	—	—	—	13.0	—	—	—	—	—	—	2.6	—	—	—

The carapace is ornamented by very fine granulation.

Comparisons.—That this crab belongs in the Dorippidae is shown by the fact that the first 2 abdominal segments are dorsal and not covered by the carapace and that the last two pairs of legs are dorsal.

Sodakus tatankayotankaensis resembles *Falconoplax kugleri* Van Straelen, 1933; *Birkhorstia ubaghsi* (Birkhorst, 1857); *Dioratiopus salebrosus* Woods, 1953, and *Torynomma quadrata* Woods, 1953; in general carapace shape. It is closest in shape and aeration to *T. quadrata* Woods but differs in that the carapace is more level, the widest part of the carapace is more posterior, and the orbits are smaller. The characters used by Wright and

Collins (1972, p. 33) to distinguish the Cymonomae, Cyclodorippae, Dorippidae, and Palicae (i.e. oviduct placement, oxystome spout, and epistome reduction) are not apparent on the specimens described herein. It seems most prudent, therefore, to make this generic assignment only to the Dorippidae.

Superfamily RANINOIDAE de Haan, 1841

Family RANINIDAE de Haan, 1841

Genus RANINELLA A. Milne-Edwards, 1862

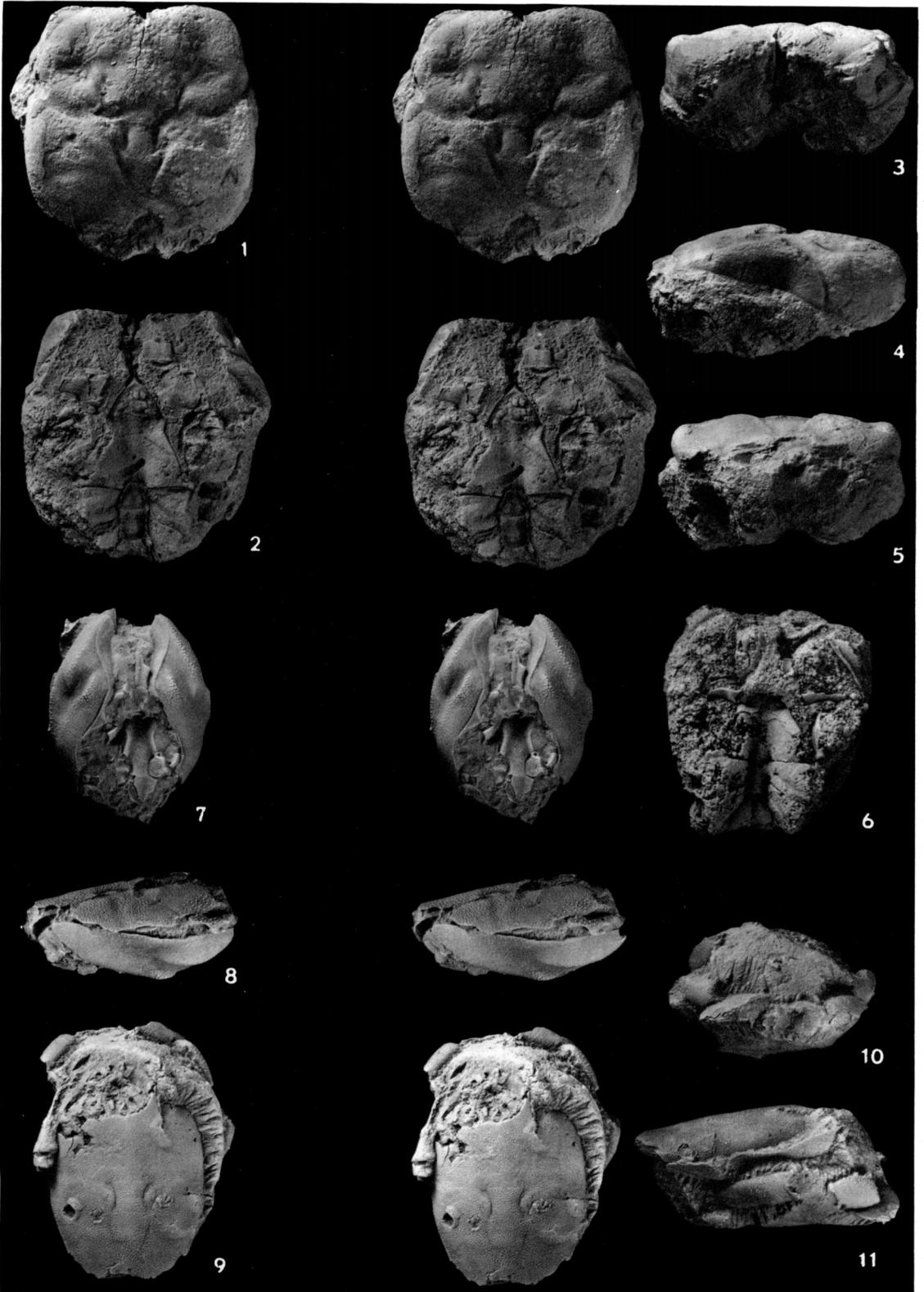
Type species.—*Raninella trigeri* A. Milne-Edwards by original designation (Glaessner, 1969, R501).

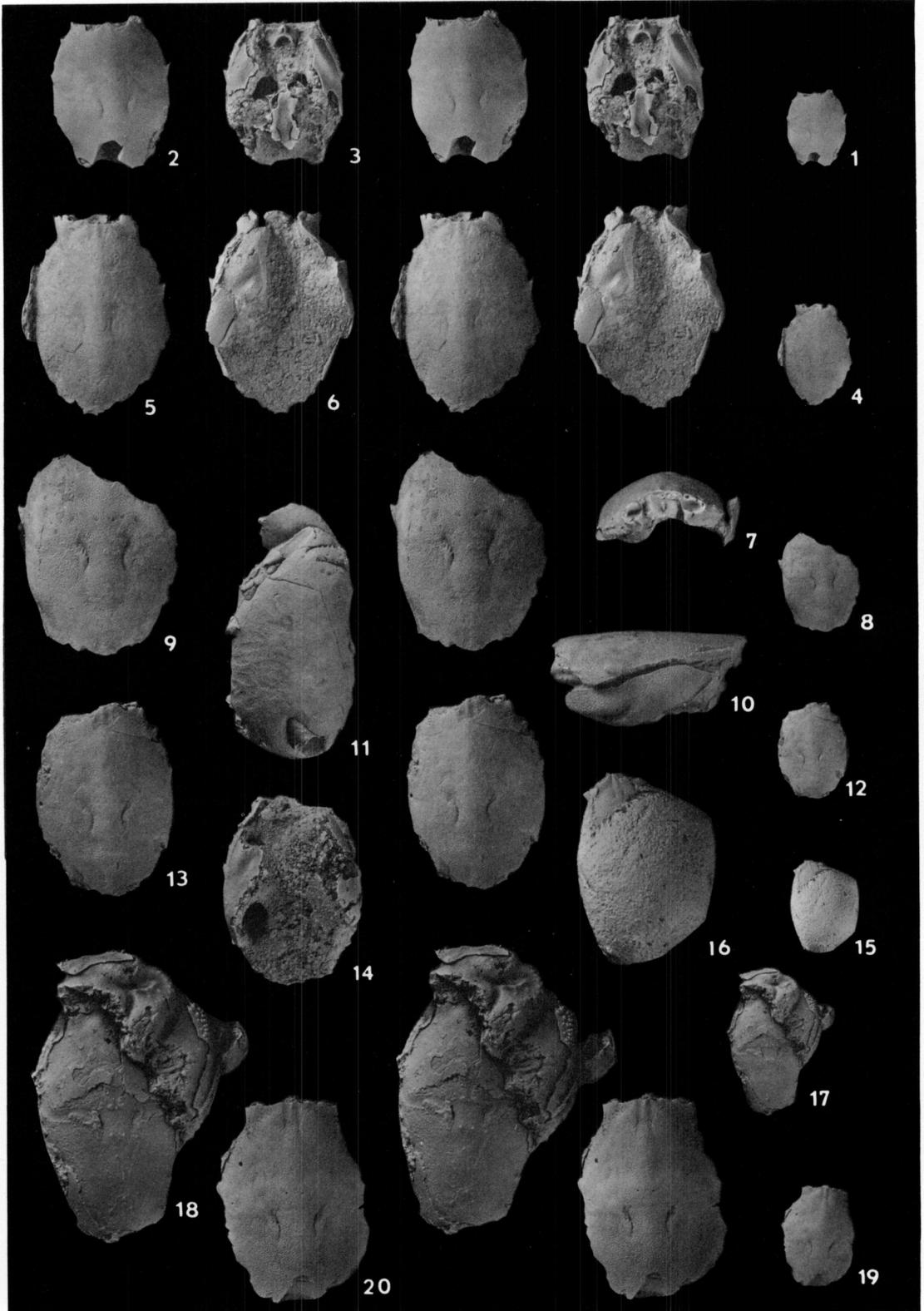
Generic diagnosis.—"Carapace ovoid, widest in anterior third, posterolateral margins converging, fronto-orbital margin with su-

EXPLANATION OF PLATE 1

FIGS. 1-6—*Sodakus tatankayotankaensis* n. sp. 1-5, Holotype. 1, Dorsal view, stereo, 2, ventral view, stereo, 3,4,5, anterior, right lateral, and posterior views, specimen GAB 4-1971 (USNM 173580). 6, Ventral view, specimen GAB 4-2030 from the Sitting Bull Locality, Mobridge, So. Dak., $\times 2$.

7-11—*Raninella oaheensis* n. sp. 7, Sternal, stereo, and 8, right lateral stereo view of specimen GAB 15-1 from Counselor Creek locality. 9, Dorsal stereo view, 10, anterior view, and 11, right lateral view of specimen GAB 12-3 (USNM 173581) from the Peoria Bottom locality, $\times 2$.





praorbital fissures, 1 or more pairs of antero-lateral spines. Only lateral cardiac grooves marked; sternum narrowed between 2nd pereopods; buccal frame long and narrow." (Glaessner, 1969, R501).

Range.—Upper Cretaceous to Paleocene, Europe and North America.

RANINELLA OAHEENSIS Bishop n. sp.

Pl. 1, figs. 7–11; Pl. 2, figs. 1–19;

Text-fig. 5

Range.—Campanian to Maastrichtian.

Etymology.—The trivial name is derived from the type locality.

Types.—The holotype (GAB 4-1967) is deposited in the United States National Museum (USNM 173589). Three paratypes (GAB 12-3, USNM 173581; GAB 4-1968, USNM 173584; and GAB 4-1970, USNM 173583) are from the Pierre Shale, Upper Cretaceous Series.

Occurrence.—Eleven specimens are known from the Zone of *B. grandis*: eight are from the Sitting Bull Locality, one from the Promise Locality, one from the U.S.C. & G.S. BM J 304 Locality, and one from the Peoria Bottom Locality north of Ft. Pierre (GAB 12-3). One specimen (GAB 15-1) that is questionably assignable to this taxon was collected from the Counselor Creek Locality by Mr. George Shurr in Lyman Co., South Dakota, from the Zone of *Baculites scotti* (Campanian). A well preserved specimen (Carter County Museum #6132) with very close affinities to this species was collected by Albert Fost from the Pierre Shale on Cedar Creek Anticline, southeast of Baker, Montana. This specimen is more highly sculptured than those from South Dakota.

Sample size and preservation.—Carapace

features are observable on nine specimens, ventral features on two, orbital characters on two and posterior features on one other; one has portions of both chelipeds. One specimen (Pl. 1, fig. 9) apparently was mouthed by a small vertebrate, as is evidenced by rows of holes punched in the carapace (Bishop, 1972a).

Description.—The carapace is ovate in outline (Text-fig. 5) longitudinally convex and transversely very convex. The length is 1.6 times the width (Table 3). The carapace is widest midway along the carapace. There are forward pointing marginal spines one-third the distance from the front. The width of the carapace increases somewhat posterior to the spines. The width of the carapace including the small spines is very nearly equal to the maximum carapace width which is found across the branchiocardiac grooves. The antero-lateral margins converge anteriorly until the width at the base of the orbits is 60% of the maximum carapace width. The outer margins of the orbits diverge anteriorly to 64% of the carapace width. The outward flaring orbits carry two fissures in the upper orbital margin, the innermost of which is the deeper. The frontal margin issues from this innermost fissure and is produced to form the rostrum. The rostrum is narrow, long, and the shape of an isosceles triangle; its edges are raised to enclose a shallow furrow. The posterior angles are sharp and the posterior margin is slightly convex.

The carapace is not strongly ornamented. The branchiocardiac grooves are present as sinuous curves sharply defined around the cardiac region (Text-fig. 5). A change in slope just

EXPLANATION OF PLATE 2

FIGS. 1–20—*Raninella oaheensis* n. sp. 1–3, Lateral spine and sternal plastron. 1, Dorsal, $\times 1$, 2,3, dorsal and ventral stereo, $\times 2$, specimen GAB 4-1970 (USNM 173583). 4–7, Orbital and pterygostomial regions. 4, Dorsal, $\times 1$, 5,6, dorsal and ventral stereo, $\times 2$, 7, anterior, $\times 1$, specimen GAB 4-1968 (USNM 173584). 8–10, Lateral spines, branchial-cardiac furrow, and gastric pits. 8, Dorsal, $\times 1$, 9, dorsal, stereo, $\times 2$, 10, left lateral, $\times 2$, specimen GAB 4-1975. 11, *Raninella oaheensis* preserved in concretion with *Dakoticanter overanus* Rathbun, $\times 1$, specimen GAB 9-19. 12–14, Coarsening of granulation near orbits. 12, Dorsal $\times 1$, 13, dorsal, stereo, $\times 2$, 14, ventral, $\times 2$, specimen GAB 4-1969. 15–16, Anterior part of *Raninella* protruding from concretion. 15, Dorsal, $\times 1$, 16, dorsal, stereo, $\times 2$, specimen GAB 4-1983. 17–18, Holotype of *Raninella oaheensis* with exfoliated carapace preserved under a *Dakoticanter*. 17, Dorsal, $\times 1$, 18, dorsal, stereo, $\times 2$, specimen GAB 4-1967 (USNM 173589). 19–20, Anterior of carapace. 19, Dorsal, $\times 1$, 20, dorsal, stereo, $\times 2$, specimen 10-136.

behind the orbits forms a broad transverse depression. A very faint pair of grooves are present near the anterior on either side of the gastric region.

The antero-lateral margin is dominated by the large, forward pointing spine one-third the distance from the front. About one-third the distance from the base of the orbit to this spine is a smaller marginal spine which is variable in size. On one specimen the anterior spine position is taken by two spines, one above the other. Between these two spines are two tubercles.

A pair of gastric pits are present one on either side of the medial axis just ahead of the place where the branchiocardiac furrow starts.

An exfoliated specimen (GAB 4-1967) has four nodes situated on the cardiac region. One of the medial nodes is situated on a line that passes through the anterior end of the branchiocardiac furrows, and the other is situated at the center of the cardiac region. One-half of the distance between the medial spines and on either side of the mid-line are two nodes which are situated on a transverse line that passes through the anterior part of the cardiac region.

The central portion of the dorsal surface is finely punctate, the punctae continuing to the lateral margins. The lateral edges are finely granulate and raised into a rim along the postero-lateral and posterior margins. The density of granules decreases away from the carapace edge becoming absent on the central part of the carapace. A few large granules forming short, longitudinal fields are situated behind the outer edge of each orbit.

The orbits are elongate-ovate and are inclined outward, forward, and a little downward. Each orbit has two fissures on the dorsal side and one on the ventral side. The outermost of the dorsal fissures is partly closed and the inner-most is open, forming a narrow slot between the orbit and the rostrum. The ventral fissure lies below and a little inside the outer-most one on the upper margin; it is deep and narrow.

The buccal frame is narrow, and sinuous, one-fifth the carapace width wide and half the carapace width in length. It is bordered by a broad, flat area that is smooth except for a few granules along the edge. A narrow ridge one granule wide separates the flat field from the rest of the reflexed carapace. From the base of

the buccal frame, a raised, narrow, granulated ridge forms the sternal margin of the carapace for most of the distance to the posterior margin. There is a smooth curve where it goes around the base of the cheliped. Inside the raised ridge there is a triangular projection between the first two appendages.

The pterygostomial region is wedge-shaped, narrowing posteriorly. The posterior half of the subbranchial region is inflated and forms a single convex longitudinal ridge. On line with the branchiocardiac grooves, the single ridge bends downward following the carapace edge forming a lower ridge and sweeps forward to the base of the buccal frame. On line with the anterior end of the branchiocardiac groove a second (upper) ridge begins. It widens and becomes more pronounced anteriorly. The upper ridge runs forward to the top of the buccal frame. The reflexed part of the carapace is punctate. The ridges are granulate. The two ridges are separated by a broad shallow depression. A well defined line of weakness forming the pleural suture is present on the reflexed portion of the carapace. It runs from the lower and inner side of the orbit along and under the lateral margin between the broad depression and the upper ridge; its lower edge is granulated. This line of weakness forms a depression along the anterior fourth of the carapace.

The anterior of the sternum is about the same width as the base of the buccal frame. The sternum is narrowed by crescentic emargination around the bases of the pereopods. The emargination around the base of pereopod 2 is much greater than around pereopods 1 and 3 giving rise to a much narrowed sternum between the second pereopods. The anterior edges of the sternum are raised into a ridge forming a medial groove back to the narrowing between the second pereopods.

The part of the third maxilliped (Pl. 2, fig. 7) that is preserved is narrow at the base. It broadens anteriorly to fill the enlarging buccal area. A broad, shallow furrow runs down the middle of the exognath; the proximal end has a hook-like process which bends inward and backward.

The merus, carpus, and propodus of the right cheliped and the carpus, propodus, and dactylus of the left cheliped are preserved on a single specimen. The granulate merus is

slightly greater than half the carapace width in length, and nearly round in cross section; the density of granulation increases dorsoventrally.

On the propodus the palm is extremely flattened, being about one-fourth as thick as it is long, about the same length as the carpus and nearly as wide as long. The dactylus is short.

The merus of the second walking leg is short, round, and granulate.

Comparisons.—The narrow restricted orbital regions and the nature of the sternum indicate that this species belongs in *Raninella*. *Raninella oaheensis* differs from the type species, *R. trigeri* A. Milne-Edwards, by having smaller antero-lateral spines and the antero-lateral spines farther back from the front. The widest part of the carapace is more posterior and less well defined in *R. oaheensis*. The carapace is much more ovate in *R. oaheensis* than *R. elongata* Milne-Edwards, 1861, from the Cenomanian of France and does not have the distinctive crescentic antero-lateral spines of that taxon. *Raninella mucronata* Rathbun, 1935, from the Denton Clay of Texas is more constricted posteriorly than *R. oaheensis*. *Raninella oaheensis* is larger and not as circular as *R. tridens* Roberts, 1962, from the Merchantville Formation of New Jersey which does not apparently have the flared orbits with two supraorbital fissures. *Raninella oaheensis* apparently differs from *R. testacea* Rathbun, 1926, from the Ripley Fm. of Coon Creek, Tennessee, by having a longer rostrum, lacking subhexagonal granules, the shallow medial furrow on the posterior of the carapace, and in having frontal spination. *Raninella oaheensis* is not nearly as high in the carapace as *R. eocenica* Rathbun, 1935, from the Sucarnooche Beds of Alabama, nor does *R. oaheensis* have such well delineated anterior spination.

This record of *Raninella* confirms the North American Western Interior record of the genus (Gill and Cobban, 1966, A26).

ACKNOWLEDGMENTS

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